參考用

1. (7 pts) **A.** What is the C_p (the molar heat capacity) of a gas which $C_v = 48$ J/(Kmole) at 298 K? (1 pt)

   B. When 3.00 L of 4.00 M $Ba(NO_3)_2$ at 25.0°C is mixed with 3.00 L of 4.00 M Na_2SO_4 at 25°C in a calorimeter, the temperature of the mixture increases to 45°C. The specific heat capacity of the solution is 4.18 J $°C^{-1}$ g^{-1}, calculate the enthalpy change per mole of $BaSO_4$ formed. (2 pts)

   C. For an ideal gas compressed from 1V to 16V reversibly and isothermally at P atm, how much energy (L atm pre mole) it releases as heat to the surroundings. (Ans = ? PV; 2 pts)

   D. At what temperatures the following process will be spontaneous at 1 atm? (2 pts)

   A (l) —> A (g) $\Delta H° = 124.0$ kJ/mol and $\Delta S° = 93.0$ $JK^{-1}mol^{-1}$

2. (8 pts) One mole of an ideal gas that is taken from state A ($P_A = 10$ atm, $V_A = 30$ L) to state B ($P_B = 10$ atm, $V_B = 60$ L, expansion under constant pressure). Calculate *q, w, ΔE and* Δ*H* for the following table. (the unit is kJ; please draw the following table in your answer paper)

State A $P_A = 10$ atm $V_A = 30$ L → State B $P_A = 10$ atm $V_A = 60$ L

kJ	A → B
w	2 pt
q	2 pt
ΔE	2 pt
ΔH	2 pt

3. (5 pts) The molar heat capacities for H_2O (s), H_2O (l) and H_2O (g) are 37.5, 75.3 and 36.4 J K^{-1} mol^{-1}, respectively, and the enthalpy of fusion and vaporization for water is 6.03 and 40.7 kJ/mol, respectively. Calculate the change in entropy that occurs when a sample of 144 g of –30 °C ice is placed in 216 g of 100 °C water. Calculate the final balance temperature (1 pts), and then show your calculation for the ΔS of this mixing. (4 pts)

(You don't need to give the final calculated data, only show the calculation process)

4. (6 pts) **A.** For the ammonia synthesis reaction, $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. if $\Delta G° = -30$ kJ per mole. Show your ΔG calculation to predict the reaction direction in which the system will shift to reach equilibrium when the following reactants and products are mixed at 25 °C. (3 pts)

   $P_{NH3} = 9.0$ atm, $P_{N2} = 5.0$ atm, $P_{H2} = 6.0$ atm,

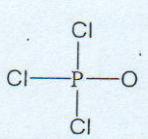
   B. The value of K_p is 3×10^{-5} at 900 K for a reaction which with the value of $\Delta H° = -50$ kJ, calculate the value of K_p at 600 K for this reaction. (3 pts)

(You don't need to give the final calaulated data, only show the calculation process)

5. (5 pts) **A.** Draw the best Lewis structures and predict their structure arrangements (geometry) of the following compounds. (3 pts, 1 pt each)

   a. ClF_3 b. IF_5 c. TeF_4

   B. The possible atom arrangement is given for **$POCl_3$**. Finish the corresponding Lewis structure and assign the formal charge to the central atom. (2 pts)



注意:背面有試題

參考用

6. (10 pts) The first atomic explosion was detonated in the desert north of Alamogordo, New Mexico, on July 16, 1945. What fraction of the strontium-90 ($t_{1/2}$ = 28 yr, 10 months) originally produced by that explosion still remained as of August 16, 2017?

7. (5 pts) The space shuttle orbiter utilizes the oxidation of methyl hydrazine by dinitrogen tetroxide for propulsion: Using the bond energies in the following Table to calculate ΔH for this following reaction.

$5\ N_2O_4(l) + a\ N_2H_3CH_3\ (l) \rightarrow b\ H_2O + c\ N_2 + d\ CO_2$

(Note: unbalanced! Need to make sure that you got the best Lewis structures for each compound)

TABLE 13.6 Average Bond Energies (kJ/mol)

Single Bonds						Multiple Bonds	
H—H	432	N—H	391	I—I	149	C=C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O=O	495
H—Br	363	N—Cl	200			C=O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N=O	607
C—H	413	O—H	467	S—Cl	253	N=N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	S—S	266	C=N	615
C—O	358	O—Cl	203			C≡N	891
C—F	485	O—I	234	Si—Si	340		
C—Cl	339			Si—H	393		
C—Br	276	F—F	154	Si—C	360		
C—I	240	F—Cl	253	Si—O	452		
C—S	259	F—Br	237				
		Cl—Cl	239				
		Cl—Br	218				
		Br—Br	193				

*C=O (CO_2) = 799

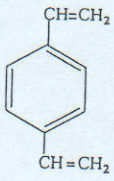
8 (6 pts) A. For the following cell: $Al + Zn^{2+} \rightarrow Al^{3+} + Zn$ **(Note : unbalanced!).** Calculate it's cell potential at 25°C. **(2 pts)** ($Al^{3+} + 3\ e^- \rightarrow Al$, Standard reduction Potential = -1.66 V; $Fe^{3+} + 3\ e^- \rightarrow Fe$, Standard reduction Potential = -0.036 V; $Zn^{2+} + 2\ e^- \rightarrow Zn$, Standard reduction Potential = -0.76 V; $Cr^{3+} + 3\ e^- \rightarrow Cr$, Standard reduction Potential = -0.73 V)

B. For the following electrolytic cell: $Cu^{2+} + Zn \longrightarrow Zn^{2+} + Cu$

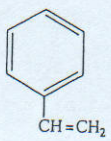
Determine the mass of the metal plated out when a current of 12 ampers is passed for 3 hour through this cell. (2 pts; Mw of Zn = 65.4 and Cu = 63.55) **(2 pts)**

C. Write the anode reaction for a H_2-O_2 fuel cell. **(2 pts)**

9. (10 pts) Polystyrene can be made more rigid by copolymerizing styrene with divinylbenzene. What purpose does the divinylbenzene serve? Why is the copolymer more rigid?



Divinylbenzene



Styrene

注意:背面有試題

參考用

10. (8 pts) A. The reaction between bromate ions and bromide ions in acidic aqueous solution is given by the following equation: $BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(l) + 3H_2O(l)$

Using the results of the following four experiments to determine the orders for all three reactants (**3 pts**) and calculate the rate constant (k). (**1 pt**)

Exp.	BrO_3^- (M)	Br^- (M)	H^+ (M)	Measured Rate
1	0.2	0.4	0.2	1.6×10^{-5}
2	0.4	0.2	0.4	6.4×10^{-5}
3	0.4	0.4	0.2	3.2×10^{-5}
4	0.2	0.4	0.4	6.4×10^{-5}

B. Using the Steady-State Approximation for the reaction:

$2\,NO\,(g) + H_2\,(g) \rightarrow N_2O\,(g) + H_2O\,(g)$,

Which may proceed via the following mechanism:

$$2NO \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} N_2O_2$$

$$N_2O_2 + H_2 \xrightarrow{k_2} N_2O + H_2O$$

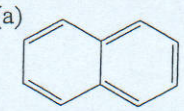
B1. Using the decomposition of H_2 to derive the rate law. (**3 pts**)

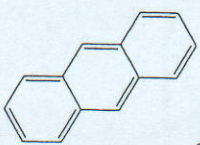
B2. If the $[H_2]$ is pretty high, derive the new (simpler) rate law. (**1 pt**)

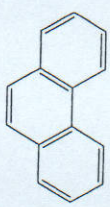
11. (10 pts, 2 pts each) How many bonds could each of the following chelates form with a metal ion?

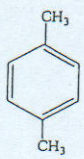
(a) acetylacetone (b) bipyridine (c) diethylenetriamine (d) porphine (e) 1,10-phenanthroline

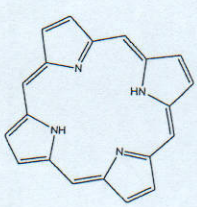
12. (10 pts, 2 pts each) Giving the general names of the following compounds.

(a) 

(b) 

(c) 

(d) 

(e) 

13. (10 pts, 5 pts each) Rank the following 0.10 M solutions in order of increasing pH.

(a) HI, HF, NaF, NaI

(b) $C_6H_5NH_3NO_3$, $NaNO_3$, NaOH, HOC_6H_5, HNO_3